U.S. Office of Naval Research International Field Office (ONRIFO)

Title: C4-IT 02-001 Workshop on Knowledge Support for Coalition Operations (KSCO 2002)

Author: Howard Marsh

Date: 7 May 2002

These reports summarize global activities of S&T Associate Directors of the Office of Naval Research International Field Offices (ONRIFO). The complete listing of newsletters and reports are available under the authors' by-line on the ONRIFO homepage: http://www.ehis.navy.mil/onrnews.htm, or by e-mail to respective authors.

TABLE OF CONTENTS

Keywords

Artificial Intelligence
Coalition Operations
Decision Support
Intelligent Agents
Interoperability
Joint Battlespace Infosphere
Knowledge Systems
Semantic Web

Summary

A workshop on Knowledge Support for Coalition Operations (KSCO) was held in Toulouse, France during the week of 22 April 2002. This workshop (KSCO 2002) was held in conjunction with the 6th International Conference on Artificial Intelligence for Planning and Scheduling (AIPS 2002). KSCO 2002 emphasized a mixture of basic research on intelligent agents and applied research and development for experimentation with agents working across heterogeneous environments. The workshop was organized and managed by Prof. Austin Tate of the University of Edinburgh and included very strong participation from DARPA and the US Air Force. The emphasis of the discussions was in areas of direct interest to the Air Force's Joint Battlespace Infosphere (JBI) initiative and the Coalition Agents Experiment (CoAX) sponsored by DARPA.

Background

The following introduction is quoted from the proceedings of KSCO 2002.

"The first Knowledge Systems for Coalition Operations (KSCO) meeting was held in Edinburgh in May 1999 and focused on Knowledge-Based Planning for Coalition Operations. An international working group of interested individuals was formed at that meeting to encourage international collaboration on KSCO. The KSCO-2002 conference is the second in a series of international meetings which aims to bring together practitioners and key decision makers in coalition operation management with researchers from areas of knowledge representation and reasoning, planning, multi-agent systems and related areas in order to exchange experience and ideas, share inspiration and suggest novel concepts. Practitioners benefit from meeting each other and from learning the possibilities of recent research achievements while researchers will get inspiration from each other and links to potential end users of their ideas."

Additional information about this workshop, including the presentations in pdf format, can be found at the following url:

http://www.aiai.ed.ac.uk/~arpi/COALITION/KSCO/ksco-2002.html

Participants and Interests

The participants at this workshop were a diverse mix of government, university, and research center personnel. Representation was particularly strong from the US Air Force Research Laboratory (AFRL) and from the Defense Advanced Research Projects Agency (DARPA) and its researchers at universities and contractor organizations.

Participation from the US Navy and its research community was very limited. Ruth Willis from the Naval Research Laboratory, Howard Marsh from the ONR International Field Office, and Jeff Grossman from the SPAWAR Systems Center were the only formal representatives of US Navy interests at the workshop. Sue Numrich, who is currently with the Defense Modeling and Simulation Office and is a former NRL/ITD person, was also in attendance. Lee Kollmorgen (former CNR) was also present to represent Dylan Schmorrow from DARPA/ITO. Other than these people, Navy interests were not represented.

A number of topics were covered, mainly involving the use of intelligent software to support coalition planning, with a large emphasis on distributed, collaborating agents.

Major Areas of Discussion

The presentations and discussions covered a relatively wide range of topics associated with artificial intelligence and agents. Some of the papers were not particularly well focused on the main theme of the workshop, but most did address challenges and technical approaches related to interoperability across heterogeneous software environments and development of automation to provide intelligent treatment of information and support to decision making.

The Air Force's JBI initiative was clearly a major topic for discussion and raised a number of issues regarding the ability of a publish/subscribe architecture to serve the needs of a coalition force. This strong Air Force presence was due, in part, to the AFRL sponsorship of the workshop and to the presence of senior personnel from AFRL. The JBI discussions were very good in terms of presenting a relatively clear and comprehensive picture of the JBI vision and approach. The presentations led to discussions of the role and technical feasibility of the proposed "fuselets" and the problem of multiple security domains and the need for a mechanism to assure adequate management of "information ownership". There is clearly need for much more work in these areas. Network issues and delivery assurance for the JBI architecture were discussed to a very limited extent and were not a major focus of the workshop.

The DARPA-sponsored Control of Agent Based Systems (CoABS) and Coalition Agent Experiment (CoAX) were also major topics of discussion. Presentations included both directly related CoABS and CoAX talks and indirectly related talks such as the one from the Czech Technical University that dealt with distributed collaborating agents in a realistic coalition operation. These papers are included in the material on the web site identified above. The main point in the CoABS and CoAX presentations and discussions is that the work initiated by Jim Hendler while he was at DARPA and continued by Dylan Schmorrow has resulted in a grid environment in which distributed, heterogeneous agents can collaborate with a reasonably small amount of hand-crafted "glue code" and mediation. However,

the ability to construct an ad hoc coalition will still be somewhat laborious and will rely on using agents that have been developed in one of the environments that CoABS has considered.

Considerable discussion was devoted to the ability of agents to exchange information in a meaningful way and to collaborate across diverse operational organizations. Several participants, principally Paul Labbe from Canada and Howard Marsh from ONRIFO, questioned the ability of such collaboration unless shared models of the agents included specific information about the rules under which the agents respond to information inputs. This would involve a high degree of information sharing regarding the specific "agendas" of each participating organization as well as the specific "rules of behavior" (more than just the normal rules of engagement) for each agent. The work by the Czech Technical University treats this area to some degree but not to the full extent needed to develop standards for specifying internal agent behaviors and certainly not with respect to the security, privacy, and sensitivity issues involved with publishing this sort of information about an agent's internal structure.

The use of agents for planning and decision support also received attention, and the discussions included the use of software for both non-adversarial and adversarial planning. One fact is very clear: In order for an agent, or a set of collaborating agents, to support decision making, these agents must have very well defined models for the behavior of the external environment (e.g. the forces). In non-adversarial situations, these behaviors can be provided in terms of general "rules of thumb" or expert decision rules. For adversarial situations, the behaviors are determined to a large extent by the adversary's anticipated reactions to specific situations. Since a competent adversary will often be unpredictable, it is not clear that intelligent software can really handle these problems at any level above the very tactical engagement level or the very high operational or strategic command level. At the lowest (engagement) level, the responses can probably be modeled according to sensor, weapon, and platform performance, and a Monte Carlo process could be used to display the variances. At the highest levels, the planning involves mainly the deployment and sustainment factors, assuming relatively broad and general behaviors of the adversary. However at the level of Operational Control and Tactical Command, the mind of the adversary is extremely important, and only a very predictable (and therefore "user-friendly enemy") can be handled. Consequently, it appears that the most obviously attractive use of decision support agents would be for planning transportation, logistics, and deployment, and for managing and controlling information networks. Another potentially attractive use would be for execution-oriented planning and management of specific tasks such as specific calls for fire or servicing of nominated targets. More ambitious uses to develop specific operational or tactical maneuver and fire plans could be very questionable since the human adversary is able to respond in ways that were never modeled. This is what wins wars.

As noted previously, the question of information "ownership" was also raised, once again by Howard Marsh and Paul Labbe. There is a clear need to provide some sort of mechanism to assure that those participants who contribute information can retain control of that information. This is not only required for nonrepudiation; it is also required for coherency of the information base. In existing information networks, the Navy has found a need for a track supervisor to have overall authority for managing the information. This is the role of the Anti-Air Warfare Coordinator (AAWC) and the Force Over-the-Horizon Track Coordinator (FOTC) in existing Navy data networks, and it will be needed in any multi-source data network of the future. The Air Force concept for JBI does not yet include this function, and the problem may be further exacerbated by the use of "fuselets" to correlate, integrate, and fuse information and also by the presence of multiple domains (nations, forces, etc) that contribute and use information. This issue is a potential show-stopper if it is not addressed.

Conclusion/Finding

The KSCO 2002 workshop was an excellent forum for discussion of a number of important issues and approaches involving intelligent agents. The limited involvement of Navy personnel and Navy-sponsored researchers was a large disappointment, since the Navy has been making major strides in applying intelligent software to these types of problems.

The Air Force JBI appears to have significant momentum in the research community, but it is not clear if this concept and approach has been adopted by the Air Force as a basis for major program funding equivalent to the Navy's commitment to FORCEnet. The JBI concept still requires much work to address the issues of publish/subscribe in an expeditionary radio network environment and in a coalition environment. Work is also needed to address the issues related to information integration, semantic interoperability, information stimulus-reaction interoperability (rules of behavior), and information ownership.

CoABS and CoAX appear to be good technology bases for establish interoperability across heterogeneous agent-based domains. However, much work will be needed to progress from the laboratory and experimentation stage to actual operational usefulness. The CoABS/CoAX community can work the issues among themselves, but there is need for a set of widely adopted standards and procedures to make the transition from research to operational systems.

A strong recommendation is that the Navy should begin to participate with this group to a much greater extent. The Navy research community has much to contribute in a number of critical areas, and it is in the Navy's interests to be part of this group.

Contacts

The following are principal points of contact at the workshop. A full list of the participants is included in the web site indicated previously.

Austin Tate, University of Edinburgh, a.tate@ed.ac.uk

Dylan Schmorrow, DARPA/ITO, dschmorrow@darpa.mil

Scott Fouse, ISX Corporation (Supporting DARPA/ITO), fouse@isx.com

Mark Linderman, AFRL, mark.linderman@rl.ar.mil

Northrup Fowler, AFRL, Northrup.Fowler@rl.af.mil

Jim Hendler, University of Maryland, hendler@cs.umd.edu

Return to ONRIFO Newsletters